IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Loucas Tsakalakos et al.	§	Group Art Unit:	1754
	§	Confirmation No.:	9948
Serial No.: 10/722,700	§		
Filed: November 25, 2003	§	Examiner:	Daniel McCracken
For: ELONGATED NANO-STRUCTURES AND RELATED DEVICES	§	Atty. Docket:	139081-1/SWA GERD:0662

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SUPPLEMENTAL APPEAL BRIEF
PURSUANT TO 37 C.F.R. §§ 41.31 AND 41.37

Sir:

In response to the Notice of Non-Compliant Appeal Brief mailed on January 16, 2008, the Appellants hereby submit this Supplemental Appeal Brief with a corrected copy of the appealed claims. The Appellants also submit this Appeal Brief in furtherance to the Notice of Appeal and the Pre-Appeal Brief Request for Review electronically filed on July 30, 2007, and also in furtherance to the Panel Decision mailed on August 15, 2007. In the Notice of Non-Compliant Appeal Brief, the Examiner indicated that the Appendix of Claims on Appeal (section 10) included an incorrect copy of the appealed claims, and also that the Status of Claims (section 3) included an incorrect status of the claims. Regarding the Appendix of Claims on Appeal (section 10), the Appellants hereby submit a corrected copy of the appealed claims based on the Interview Summary and Amendment filed on January 23, 2007. The Appellants stress that the original Status of Claims (section 3) is correct and consistent with the corrected copy of the appealed

claims. As a result, the Appellants did not make any changes to the Status of Claims (section 3).

Authorization for Extensions of Time and Payment of Fees

In accordance with 37 C.F.R. § 1.136, the Appellants hereby provide a general authorization to treat this and any future reply requiring an extension of time as incorporating a request thereof. The Appellants submit that no fees are currently due in association with this Supplemental Appeal Brief. The Appellants previously paid the requisite fees for an extension of time and the Appeal Brief along with the original filing of the Appeal Brief on October 30, 2007. However, if any fees are necessary to advance this appeal, then the Appellants authorize the Commissioner to charge the requisite fees to Deposit Account No. 07-0868; Order No. 139081-1 (GERD:0662/SWA).

1. REAL PARTY IN INTEREST

The real party in interest is General Electric, the Assignee of the above-referenced application by virtue of the Assignment to General Electric recorded at Reel 015774 and Frame 0292. Accordingly, General Electric will be directly affected by the Board's decision in the pending appeal.

2. RELATED APPEALS AND INTERFERENCES

Appellants are unaware of any other appeals or interferences related to this Appeal. The undersigned is Appellants' legal representative in this Appeal.

3. STATUS OF CLAIMS

Claims 30, 32-52, and 54-72 are currently pending, are currently under final rejection and, thus, are the subject of this Appeal. Claims 1-29, 31, and 53 are cancelled.

4. STATUS OF AMENDMENTS

There are no outstanding amendments to be considered by the Board.

5. **SUMMARY OF CLAIMED SUBJECT MATTER**

The present invention relates generally to the field of nano-scale structures and, more specifically, to elongated nano-structures. *See*, Application, paragraph 1. Carbide materials may be preferred due to their chemical stability, mechanical hardness and strength, high electrical conductivity, and relatively low work function. These characteristics make them particularly suited to the environment that may be found in a CT system. Currently, the predominating approach to synthesizing carbide nanorods has been to use a carbon nanotube (CNT) as a template on which a reaction is carried out between the CNT and a metal, metal oxide, or metal iodide in vapor form to produce metal carbide nanorods. However, demonstration of CNT conversion in a device structure has not been shown to date, presumably owing to a number of risks associated with such a process, including the large volume changes (about 60% for CNTs that are converted to Mo_2C), adhesion to the substrate after conversion, and the ability to maintain alignment.

The Application contains five independent claims 30, 38, 44, 54, and 55, which is the subject of this Appeal. The subject matter of these claims is summarized below. With regard to the aspect of the invention set forth in independent claim 30, discussions of the recited features of claim 30 can be found at least in the below cited locations of the specification. Specifically, independent claim 30 recites a field emission device (e.g., 300), comprising a substrate (e.g., 310) having a top side and an opposite bottom side; a conductive epitaxial buffer layer (e.g., 211) affixed to the top side of the substrate (e.g., 310); a dielectric layer (e.g., 314) disposed on the top side; a conductive layer (e.g., 316) disposed on top of the dielectric layer (e.g., 314) opposite the substrate (e.g., 310), the conductive layer (e.g., 316) and the dielectric layer (e.g., 314) defining a cavity (e.g., 317) extending downwardly to the substrate (e.g., 310); and at least one nanorod (e.g., 318) affixed to the substrate (e.g., 310) via the conductive epitaxial buffer layer (e.g., 211) and substantially disposed within the cavity (e.g., 317), wherein the conductive epitaxial buffer layer (e.g., 211) remains after formation of the at least one nanorod (e.g., 318, 418). *See, e.g.,* Application, paragraphs 42-47; FIGS. 2D, 3D, 4D and 4E.

With regard to the aspect of the invention set forth in independent claim 38, discussions of the recited features of claim 38 can be found at least in the below cited locations of the specification. Specifically, independent claim 38 recites a nanostructure, comprising an inorganic substrate (e.g., 110) having a top side and a bottom side; an epitaxial conductive buffer layer (e.g., 211) disposed adjacent to the top side; and a plurality of elongated carburized metal nanostructures (e.g., 120) extending from the epitaxial conductive buffer layer (e.g., 211). Independent claim 38 further recites the epitaxial conductive buffer layer (e.g., 211) remains after formation of the plurality of elongated carburized metal nanostructures (e.g., 120). Finally, independent claim 38 recites the plurality of elongated carburized metal nanostructures (e.g., 120) comprises catalyst particles (e.g., 112) disposed between the epitaxial conductive buffer layer (e.g., 211) and the plurality of elongated carburized metal nanostructures (e.g., 120) at least prior to growth of the plurality of elongated carburized metal nanostructures (e.g., 120). *See, e.g.,* Application, paragraphs 42-44; FIGS. 2A, 2B, 2C, and 2D.

With regard to the aspect of the invention set forth in independent claim 44, discussions of the recited features of claim 44 can be found at least in the below cited locations of the specification. Specifically, independent claim 44 recites a field emission device (e.g., 300) comprising a substrate (e.g., 310) having a top side and an opposite bottom side; a dielectric layer (e.g., 314) disposed on the top side; a conductive layer (e.g., 316) disposed on top of the dielectric layer (e.g., 314) opposite the substrate (e.g., 310), the conductive layer (e.g., 316) and the dielectric layer (e.g., 314) defining a cavity (e.g., 317) extending downwardly to the substrate (e.g., 310). Independent claim 44 further recites a conductive platform (e.g., 420), having a top surface, disposed on the top side of the substrate (e.g., 310) within the cavity (e.g., 317), wherein the conductive platform (e.g., 420) is independent from catalyst particles (e.g., 404) configured to grow the at least one nanorod (e.g., 318, 418), and the catalyst particles (e.g., 404) are disposed in a channel (e.g., 402). Finally, independent claim 44 recites at least one nanorod (e.g., 418) affixed to the top surface of the conductive platform (e.g., 420) and substantially

disposed within the cavity (e.g., 317). *See, e.g.,* Application, paragraph 47; FIGS. 4A, 4B, 4C, 4D, and 4E.

With regard to the aspect of the invention set forth in independent claim 54, discussions of the recited features of claim 54 can be found at least in the below cited locations of the specification. Specifically, independent claim 54 recites a field emission device (e.g., 300), comprising a substrate (e.g., 310) having a top side and an opposite bottom side; a polycrystalline conductive diffusion barrier (e.g., 211) affixed to the top side of the substrate (e.g., 310); a dielectric layer (e.g., 314) disposed on the top side; a conductive layer (e.g., 316) disposed on top of the dielectric layer (e.g., 314) opposite the substrate (e.g., 310), the conductive layer (e.g., 316) and the dielectric layer (e.g., 314) defining a cavity (e.g., 317) extending downwardly to the substrate (e.g., 310). Independent claim 54 further recites at least one nanorod (e.g., 318) affixed to the substrate (e.g., 310) via the polycrystalline conductive diffusion barrier (e.g., 211) and substantially disposed within the cavity (e.g., 317), wherein the at least one nanorod (e.g., 318) extends from a top surface of the polycrystalline conductive diffusion barrier (e.g., 211). *See, e.g.,* Application, paragraphs 42-47; FIGS. 2D, 3D, 4D and 4E.

With regard to the aspect of the invention set forth in independent claim 55, discussions of the recited features of claim 55 can be found at least in the below cited locations of the specification. Specifically, independent claim 55 recites a nanostructure, comprising an inorganic substrate (e.g., 110) having a top side and a bottom side; a polycrystalline conductive diffusion barrier (e.g., 211) disposed adjacent to the top side; and a plurality of elongated carburized metal nanostructures (e.g., 120) extending from the polycrystalline conductive diffusion barrier (e.g., 211), wherein the polycrystalline conductive diffusion barrier (e.g., 211) is configured to inhibit formation of unwanted structures due to interaction between the inorganic substrate (e.g., 110) and reactants. *See, e.g.,* Application, paragraphs 42-44; FIGS. 2A, 2B, 2C, and 2D.

6. <u>GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL</u>

<u>Ground of Rejection Number 1 for Review on Appeal</u>:

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of Claims 30, 35, 36, 38-40, 42-51, and 56-68 over U.S. Patent No. 5,973,444 (hereinafter "Xu") in view of U.S. Patent No. 6,255,198 (hereinafter "Linthicum").

<u>Ground of Rejection Number 2 for Review on Appeal</u>:

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claim 32 as being unpatentable over Xu in view of Linthicum, and further in view of U.S. Patent No. 5,157,304 (hereinafter "Kane").

<u>Ground of Rejection Number 3 for Review on Appeal</u>:

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claim 33 as being unpatentable over Xu in view of Linthicum, and further in view of U.S. Patent No. 6,054,801 (hereinafter "Hunt").

<u>Ground of Rejection Number 4 for Review on Appeal</u>:

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claim 34 as being unpatentable over Xu in view of Linthicum, and in view of U.S. Patent No. 6,465,132 (hereinafter "Jin") taken with U.S. Patent No. 6,911,767 (hereinafter "Takai").

<u>Ground of Rejection Number 5 for Review on Appeal</u>:

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claims 37 and 52 as being unpatentable over Xu in view of Linthicum, and in further view of U.S. Patent No. 6,376,007 (hereinafter "Rowell").

Ground of Rejection Number 6 for Review on Appeal:

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claim 41 as being unpatentable over Xu in view of Linthicum, and in further view of U.S. Patent No. 6,586,093 (hereinafter "Laude").

Ground of Rejection Number 7 for Review on Appeal:

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claims 54-55 and 69-72 as being unpatentable over Xu in view of U.S. Patent No. 5,406,123 (hereinafter "Narayan").

Ground of Rejection Number 8 for Review on Appeal:

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of Claims 30, 35, 36, 38-40, 42-51, and 56-68 over Xu in view of U.S. Published Application No. 2002/0198112 (hereinafter "Paranthaman").

Ground of Rejection Number 9 for Review on Appeal:

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claim 32 as being unpatentable over Xu in view of Paranthaman, and further in view Kane.

Ground of Rejection Number 10 for Review on Appeal:

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claim 33 as being unpatentable over Xu in view of Paranthaman, and further in view of Hunt.

Ground of Rejection Number 11 for Review on Appeal:

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claim 34 as being unpatentable over Xu in view of Paranthaman, and in view of Jin taken with Takai.

<u>Ground of Rejection Number 12 for Review on Appeal</u>:

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claims 37 and 52 as being unpatentable over Xu in view of Paranthaman, and in further view of Rowell.

<u>Ground of Rejection Number 13 for Review on Appeal</u>:

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claim 41 as being unpatentable over Xu in view of Paranthaman, and in further view of Laude.

<u>Ground of Rejection Number 14 for Review on Appeal</u>:

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claims 54-55 as being unpatentable over Xu in view of Narayan. The Appellants note that this rejection is redundant in view of the seventh rejection summarized above.

7. <u>ARGUMENT</u>

As discussed in detail below, the Examiner has improperly rejected the pending claims. Further, the Examiner has misapplied long-standing and binding legal precedents and principles in rejecting the claims under Section 103. Accordingly, Appellants respectfully request full and favorable consideration by the Board, as Appellants strongly believe that claims 30, 32-52, and 54-72 are in condition for allowance.

A. <u>Ground of Rejection Number 1</u>:

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of Claims 30, 35, 36, 38-40, 42-51, and 56-68 over Xu in view of Linthicum. Of these, claims 30, 38, and 44 are independent. The Appellants stress that the Examiner's rejection is flawed in view of the legal precedent and reasons set forth below.

1. **Legal Precedent**

The pending claims must be given an interpretation that is reasonable and consistent with the *specification*. *See In re Prater*, 415 F.2d 1393, 1404-05, 162 U.S.P.Q. 541, 550-51 (C.C.P.A. 1969) (emphasis added); *see also In re Morris,* 127 F.3d 1048, 1054-55, 44 U.S.P.Q.2d 1023, 1027-28 (Fed. Cir. 1997); *see also* M.P.E.P. §§ 608.01(o) and 2111. Indeed, the specification is "the primary basis for construing the claims." *See Phillips v. AWH Corp.*, No. 03-1269, -1286, at 13-16 (Fed. Cir. July 12, 2005) (*en banc*). One should rely *heavily* on the written description for guidance as to the meaning of the claims. *See id.*

Interpretation of the claims must also be consistent with the interpretation that *one of ordinary skill in the art* would reach. *See In re Cortright*, 165 F.3d 1353, 1359, 49 U.S.P.Q.2d 1464, 1468 (Fed. Cir. 1999); M.P.E.P. § 2111. "The inquiry into how a person of ordinary skill in the art understands a claim term provides an objective baseline from which to begin claim interpretation." *See Collegenet, Inc. v. ApplyYourself, Inc.*, 418 F.3d 1225, 75 U.S.P.Q.2d 1733, 1738 (Fed. Cir. 2005) (quoting *Phillips v. AWH Corp.*, 75 U.S.P.Q.2d 1321, 1326). The Federal Circuit has made clear that derivation of a claim term must be based on "usage in the ordinary and accustomed meaning of the words amongst artisans of ordinary skill in the relevant art." *See id.*

The burden of establishing a *prima facie* case of obviousness falls on the Examiner. *Ex parte Wolters and Kuypers*, 214 U.S.P.Q. 735 (PTO Bd. App. 1979). In addressing obviousness determinations under 35 U.S.C. § 103, the Supreme Court in *KSR International Co. v. Teleflex Inc.*, No. 04-1350 (April 30, 2007), reaffirmed many of its precedents relating to obviousness including its holding in *Graham v. John Deere Co.,* 383 U.S. 1 (1966). In *Graham*, the Court set out an objective analysis for applying the statutory language of §103:

> Under §103, the scope and content of the prior art are to be determined, differences between the prior art and the claims at issue are to be ascertained, and the level of ordinary skill in the pertinent art are to be

> resolved. Against this background the obviousness or non-obviousness of the subject matter is to be determined. Such secondary considerations as commercial success, long-felt but unresolved needs, failure of others, etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented. *KSR*, *slip op.* at 2 (citing *Graham*, 383 U.S. at 17-18).

In *KSR*, the Court also reaffirmed that "a patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art." *Id.* at 14. In this regard, the *KSR* court stated that "it can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does ... because inventions in most, if not all, instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known." *Id.* at 14-15. Traditionally, to establish a *prima facie* case of obviousness, the CCPA and the Federal Circuit have required that the prior art not only include all of the claimed elements, but also some teaching, suggestion, or motivation to combine the known elements in the same manner set forth in the claim at issue. *See, e.g., ASC Hospital Systems Inc. v. Montifiore Hospital,* 221 U.S.P.Q. 929, 933 (Fed. Cir. 1984) (holding that obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention absent some teaching or suggestion supporting the combination.); *In re Mills,* 16 U.S.P.Q.2d 1430, 1433 (Fed. Cir. 1990) (holding that the mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination). In *KSR*, the court noted that the demonstration of a teaching, suggestion, or motivation to combine provides a "helpful insight" in determining whether claimed subject matter is obvious. *KSR, slip op.* at 14. However, the court rejected a *rigid* application of the "TSM" test. *Id.* at 11. In this regard, the court stated:

> The obviousness analysis cannot be confined by a formalistic conception of the words teaching, suggestion, and motivation, or by overemphasis on the importance of published articles and explicit content of issued patents. The diversity of inventive pursuit and of modern technology counsels

> against limiting the analysis in this way. In many fields it may be that there is little discussion of obvious techniques or combinations, and it often may be the case that market demand, rather than scientific literature, will drive design trends. *Id.* at 15.

In other words, the *KSR* court rejected a rigid application of the TSM test which requires that a teaching, suggestion or motivation to combine elements in a particular manner must be explicitly found in the cited prior art. Instead, the *KSR* court favored a more expansive view of the sources of evidence that may be considered in determining an apparent reason to combine known elements by stating:

> Often, it will be necessary for a court to look to interrelated teachings of multiple patents; the effects of demands known to the design community or present in the marketplace; and the background knowledge possessed by a person having ordinary skill in the art all in order to determine whether there was an apparent reason to combine in the known elements in the fashion claimed in the patent at issue. *Id.* at 14.

The *KSR* court also noted that there is not necessarily an inconsistency between the idea underlying the TSM test and the *Graham* analysis, and it further stated that the broader application of the TSM test found in certain Federal Circuit decisions appears to be consistent with *Graham*. *Id.* at 17-18 (citing *DyStar Textilfarben GmbH and Co. v. C.H. Patrick Co.,* 464 F.3d 1356, 1367 (2006) ("Our suggestion test is in actuality quite flexible and not only permits but *requires* consideration of common knowledge and common sense"); *Alza Corp. v. Mylan Labs, Inc.,* 464 F.3d 1286, 1291 (2006) ("There is flexibility in our obviousness jurisprudence because a motivation may be found *implicitly* in the prior art. We do not have a rigid test that requires a teaching to combine … ")).

Furthermore, the *KSR* court did not diminish the requirement for objective evidence of obviousness. *Id.* at 14 ("To facilitate review, this analysis should be made explict. See *In re Kahn,* 441 F.3d 977, 988 (CA Fed. 2006) ("[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness"). As our precedents make clear, however, the analysis need not seek out precise teachings directed to the specific subject matter of the challenged

claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ."); s*ee also, In re Lee,* 61 U.S.P.Q.2d 1430, 1436 (Fed. Cir. 2002) (holding that the factual inquiry whether to combine references must be thorough and searching, and that it must be based on *objective evidence of record*).

When prior art references require a selected combination to render obvious a subsequent invention, there must be some reason for the combination other than the hindsight gained from the invention itself, i.e., something in the prior art as a whole must suggest the desirability, and thus the obviousness, of making the combination. *Uniroyal Inc. v. Rudkin-Wiley Corp.*, 837 F.2d 1044, 5 U.S.P.Q.2d 1434 (Fed. Cir. 1988). One cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention. *In re Fine*, 837 F.2d 1071, 5 U.S.P.Q.2d 1596 (Fed. Cir. 1988). The Federal Circuit has warned that the Examiner must not, "fall victim to the insidious effect of a hindsight syndrome wherein that which only the inventor taught is used against its teacher." *In re Dembiczak*, F.3d 994, 999, 50 U.S.P.Q.2d 52 (Fed. Cir. 1999) (quoting *W.L. Gore & Assoc., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 1553, 220 U.S.P.Q. 303, 313 (Fed. Cir. 1983)).

It is improper to combine references where the references teach away from their combination. *In re Grasselli*, 713 F.2d 731, 743, 218 U.S.P.Q. 769, 779 (Fed. Cir. 1983); M.P.E.P. § 2145. Moreover, if the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. *In re Ratti*, 270 F.2d 810, 123 U.S.P.Q. 349 (CCPA 1959); *see* M.P.E.P. § 2143.01(VI). If the proposed modification or combination would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984); *see* M.P.E.P. § 2143.01(V).

In addition, "it is well established that product claims may include process steps to wholly or partially define the claimed product." *In re Luck*, 177 U.S.P.Q. 523, 525 (C.C.P.A. 1973). To the extent that "these process limitations distinguish the *product* over the prior art, they must be given the same consideration as traditional product characteristics." *Id.* (emphasis in original). These claims are not product-by-process claims. A product-by-process claim defines a product by laying out the method steps required to produce the product. *See Atlantic Thermoplastics Co. Inc. v. Faytex Corp.*, 23 U.S.P.Q.2d 1481, 1490 (Fed. Cir. 1992). This is far different from a mixed limitation or hybrid claim that includes a functional limitation, but does not define the product solely by method steps. The general rule for interpreting hybrid claims is that all limitations are to be given patentable effect. *See In re Angstadt*, 190 U.S.P.Q. 214, 217 (C.C.P.A. 1976).

In order to rely on equivalence as a rational supporting an obviousness rejection, the equivalency must be recognized in the prior art, and cannot be based on applicant's disclosure or the mere fact that the components at issue are functional or mechanical equivalents. *In re Ruff*, 256 F.2d 590, 118 U.S.P.Q. 340 (CCPA 1958); *see also* M.P.E.P. § 2144.06.

2. Independent claim 30 and its dependent claims

The combination of Xu and Linthicum fails to teach a conductive layer that remains after the formation of the nanostructures

Independent claim 30 recites "at least one nanorod affixed to the substrate via the conductive epitaxial buffer layer and substantially disposed within the cavity, wherein the conductive epitaxial buffer layer remains after formation of the at least one nanorod."

The Xu and Linthicum references, taken alone or in hypothetical combination, fail to teach or suggest the foregoing claim features. In particular, neither Xu nor Linthicum

teach employing a structure even remotely similar to the conductive buffer layer that remains after formation of the nanorods. Even assuming the metal catalyst film 87 of FIG. 5D or the metal catalyst film 108 of FIG. 6D of Xu as being equivalent to the conductive epitaxial buffer layer of the present claim, Appellants respectfully submit that the metal catalyst film is meant to dissolve into the gate metal during the heating in the process of formation of the nanorods. For example, a passage cited at col. 16, lines 5-10 discloses dissolving of the metal catalyst film during the formation of the nanorods. The cited passage reads:

> [H]eating in an atmosphere containing a carbon source to grow carbon emitters 78 on the exposed substrate inside of the gate openings. During heating, the metal catalyst on top of the gate metal dissolves into the gate metal and does not readily catalyze the formation of carbon fibers on the gate metal.

Therefore, the catalyst film will not remain when the nanorods are formed. Whereas, in the present claim, as illustrated in FIGS. 2D, 4D and 4E and as indicated in the description of a passage cited at paragraph 44, lines 3-9 of the present application, the present claim recites a conductive epitaxial buffer layer that remains after the formation of the nanorods to provided several advantageous features. The cited passage reads:

> The buffer layer 211 acts as a diffusion barrier and inhibits the formation of unwanted structures, such as silicides, due to interaction between the reactants and the substrate 110. The buffer layer 211 could include, for example, germanium carbide or silicon carbide applied in an epitaxial process, or a polycrystalline diffusion barrier such as W or Ti-W. In some cases <u>the buffer layer 211 should be suitable to support epitaxial growth of the nanostructure materials of interest</u>.

As mentioned in the cited passages, the conductive epitaxial buffer layer or the buffer layer facilitates growth of the nanostructures. Therefore, the present claim recites that the conductive epitaxial buffer layer remains after the nanostructures are formed.

Xu <u>teaches away</u> from having a conductive epitaxial buffer layer that remains until the formation of the nanostructures. Therefore, Xu teaches away from a

combination with Linthicum to employ a conductive epitaxial buffer layer that remains after the formation of the nanostructures. Accordingly, even if the field emission device of Xu was hypothetically formed by using the epitaxial buffer layers of Linthicum, the device will not employ a conductive epitaxial buffer layer that remains after the formation of the nanostructures. For this reason, the Xu and Linthicum references, taken alone or in hypothetical combination, cannot support a *prima facie* case of obviousness of independent claim 30 and its dependent claims.

In view of the foregoing discussion, the Appellants respectfully stress that the Xu and Linthicum references, taken alone or in hypothetical combination, cannot support a *prima facie* case of obviousness of independent claim 30 and its dependent claims.

3. Independent claim 38 and its dependent claims

Cited references, taken alone or in hypothetical combination, fail to teach or suggest a conductive epitaxial buffer layer that remain after the formation of the nanostructures

Independent claim 38 recites "a plurality of elongated carburized metal nanostructures extending from the epitaxial conductive buffer layer, wherein the conductive epitaxial buffer layer remains after formation of the plurality of elongated carburized metal nanostructures, wherein the plurality of elongated carburized metal nanostructure comprises catalyst particles disposed between the epitaxial conductive buffer layer and the plurality of elongated carburized metal nanostructures at least prior to growth of the plurality of elongated carburized metal nanostructures". As discussed above with reference to independent claim 30, the Xu reference teaches away from using a conductive buffer layer that remains after the formation of the nanostructures.

Additionally, Xu fails to teach or even suggest employing catalyst particles that are disposed between the conductive epitaxial buffer layer and the nanostructures. As

illustrated in embodiments of FIGS. 2B and 2C and as described in paragraph 44, lines 1-3 of the present application, the catalyst particles are deposited on the conductive epitaxial buffer layer, and subsequently, the nanostructures are grown from the conductive epitaxial buffer layer, thereby resulting in the catalyst particles being present between the conductive epitaxial buffer layer and the nanostructures prior to the growth of the nanostructures. The cited passage reads:

> An electrically conductive buffer layer 211, as shown in FIGS. 2A-2D, may be applied to the substrate 110 prior to the step of applying a plurality of spatially-separated catalyst particles 112 to the substrate 110.

For at least these reasons, the Appellants respectfully stress that the Xu and Linthicum references, taken alone or in hypothetical combination, cannot support a *prima facie* case of obviousness of independent claim 38 and its dependent claims.

4. Independent claim 44 and its dependent claims

Cited references, taken alone or in hypothetical combination, fail to teach or suggest a "conductive platform" such that the conductive platform is independent from catalyst particles as recited by independent claim 44.

Claim 44 recites "a conductive platform, having a top surface, disposed on the top side of the substrate within the cavity, wherein the conductive platform is independent from catalyst particles configured to grow the at least one nanorod."

Appellants respectfully submit that the Examiner is mistaken in considering the catalyst metal film of Xu equivalent to the conductive platform of the present claims. Although Appellants do not intend or suggest that the specification should be read into the claims, the Appellants reiterate that the specification is "the primary basis for construing the claims." *See Phillips v. AWH Corp.*, No. 03-1269, -1286, at 13-16 (Fed. Cir. July 12, 2005) (*en banc*). One should rely *heavily* on the written description for guidance as to the meaning of the claims. *See id.* As disclosed in the present application,

the conductive platform facilitates the growth of the nanorods. *See* Application, paragraph 47, lines 1-3. The cited passage reads:

> In another embodiment, a conductive platform 420, as shown in FIG. 4, may be disposed on the substrate 310 within a cavity formed in the dielectric layer 314.

Appellants respectfully submit that Xu does not teach or suggest any structure analogous to the conductive platform as recited in claim 44. In other words, Xu fails to teach or suggest any structure which is employed to raise the level of nanorods close to the gate opening. The metal catalyst film is used as a catalyst to enhance the growth of the nanostructures. For example, a passage at col. 12, lines 27-33 of Xu recites:

> The use of a metal catalyst film is a preferred approach. The patterns are easy to form, uniform, and accurate with high reproducibility when a metal film is used. After a catalyst pattern is defined on a substrate surface, the patterned electron emitters are fabricated by further heating the substrate in an atmosphere containing a carbon source.

Therefore, if at all, the metal catalyst film of Xu may be hypothetically similar to the catalyst particles 404 in the foregoing passage, but the metal catalyst film of Xu cannot be equated with the conductive platform recited in the present claim.

In view of these passages, the Appellants further note that the present application discloses and claim 44 recites that the "catalyst particles are <u>disposed within a channel</u>" in the conductive platform to facilitate the growth of the nanostructures. For example, a passage in paragraph 47, lines 3-5, of the present application discloses:

> At least one channel 402 is formed in the conductive platform 420 and a catalyst particle 404 is placed within the channel 402. Nanorods 418 are then grown so as to extend from the top surface of the conductive platform 420.

Xu fails to disclose a conductive platform, and therefore fails to disclose the conductive platform that has catalyst particles disposed within a channel of the conductive platform.

The secondary references do not obviate the deficiencies of Xu. Hence, the hypothetical combination of Xu with Linthicum fails to disclose a "conductive platform," as recited by independent claim 44. For at least these reasons, among others, the Appellants respectfully stress that the Xu and Linthicum references, taken alone or in hypothetical combination, cannot support a *prima facie* case of obviousness of independent claim 44 and its dependent claims.

B. **Ground of Rejection Number 2:**

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claim 32 as being unpatentable over Xu in view of Linthicum, and further in view of Kane. Claim 32 is dependent on independent claim 30. The Appellants stress that the Examiner's rejection is flawed in view of the deficiencies discussed in detail above. The additional reference does not obviate the deficiencies of Xu and Linthicum.

C. **Ground of Rejection Number 3:**

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claim 33 as being unpatentable over Xu in view of Linthicum, and further in view of Hunt. Claim 33 is dependent on independent claim 30. The Appellants stress that the Examiner's rejection is flawed in view of the deficiencies discussed in detail above. The additional reference does not obviate the deficiencies of Xu and Linthicum.

D. **Ground of Rejection Number 4:**

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claim 34 as being unpatentable over Xu in view of Linthicum, and further in view of Jin and Takai. Claim 34 is dependent on independent claim 30. The Appellants stress that the Examiner's rejection is flawed in view of the deficiencies discussed in detail above. The additional references do not obviate the deficiencies of Xu and Linthicum.

E. **Ground of Rejection Number 5:**

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claims 37 and 52 as being unpatentable over Xu in view of Linthicum, and further in view of Rowell. Claim 37 is dependent on independent claim 30. Claim 52 is dependent on independent claim 44. The Appellants stress that the Examiner's rejection is flawed in view of the deficiencies discussed in detail above. The additional reference does not obviate the deficiencies of Xu and Linthicum.

F. **Ground of Rejection Number 6:**

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claim 41 as being unpatentable over Xu in view of Linthicum, and further in view of Laude. Claim 41 is dependent on independent claim 38. The Appellants stress that the Examiner's rejection is flawed in view of the deficiencies discussed in detail above. The additional reference does not obviate the deficiencies of Xu and Linthicum.

G. **Ground of Rejection Number 7:**

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claims 54-55 and 69-72 as being unpatentable over Xu in view of Narayan. Claims 69-70 are dependent on independent claim 54. Claims 71-72 are dependent on independent claim 55. The Appellants stress that the Examiner's rejection is flawed in view of the foregoing legal precedent and the following reasons.

1. Independent claim 54 and its dependent claims

Cited references, taken alone or in hypothetical combination, fail to teach or suggest a polycrystalline conductive diffusion barrier "wherein the at least one nanorod extends from a top surface of the polycrystalline conductive diffusion barrier" as recited by independent claim 54.

Independent claim 54 recites "at least one nanorod affixed to the substrate via the polycrystalline conductive diffusion barrier and substantially disposed within the cavity, wherein the at least one nanorod extends from a top surface of the polycrystalline conductive diffusion barrier". As discussed above with reference to independent claim 30, the Xu reference discloses a resistive layer rather than a conductive epitaxial buffer layer. Moreover, the Xu reference teaches away from a conductive epitaxial buffer layer. Therefore, Xu also teaches away from employing a polycrystalline conductive diffusion barrier such that one or more nanorods extend from the top surface of the polycrystalline conductive diffusion barrier. The secondary reference fails to overcome the deficiency of the primary reference. For at least these reasons, among others, the Appellants respectfully stress that the cited references, taken alone or in hypothetical combination, cannot support a *prima facie* case of obviousness of independent claim 54 and its dependent claims.

2. Independent claim 55 and its dependent claims

Cited references, taken alone or in hypothetical combination, fail to teach or suggest a polycrystalline conductive diffusion barrier, "wherein the polycrystalline conductive diffusion barrier is configured to inhibit formation of unwanted structures due to interaction between the inorganic substrate and reactants" as recited by independent claim 55.

Independent claim 55 recites a polycrystalline conductive diffusion barrier "wherein the polycrystalline conductive diffusion barrier is configured to inhibit formation of unwanted structures due to interaction between the inorganic substrate and reactants." As discussed above with reference to independent claims 30 and 38, the Xu reference teaches away from employing a polycrystalline conductive diffusion barrier. Moreover, Xu fails to teach or even suggest a structure equivalent to the polycrystalline conductive diffusion barrier, such that the structure is configured to inhibit formation of unwanted structures due to interaction between the inorganic substrate and reactants. In a

passage cited at paragraph 44, lines 3-10, the present application discloses employing the polycrystalline conductive diffusion barrier to inhibit growth of silicides, etc. The cited passage reads:

> The buffer layer 211 acts as a diffusion barrier and inhibits the formation of unwanted structures, such as silicides, due to interaction between the reactants and the substrate 110. The buffer layer 211 could include, for example, germanium carbide or silicon carbide applied in an epitaxial process, or a polycrystalline diffusion barrier such as W or Ti-W. In some cases the buffer layer 211 should be suitable to support epitaxial growth of the nanostructure materials of interest. In other cases, epitaxy may not be necessary.

Therefore, even if the cited references are hypothetically combined with one another, the result will not be the device of the present claim. Again, for at least these reasons, the Appellants respectfully stress that the cited references, taken alone or in hypothetical combination, cannot support a *prima facie* case of obviousness of independent claim 55 and its dependent claims.

H. <u>Ground of Rejection Number 8</u>:

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of Claims 30, 35, 36, 38-40, 42-51, and 56-68 over Xu in view of Paranthaman. Of these, claims 30, 38, and 44 are independent. The Appellants stress that the Examiner's rejection is flawed in view of the foregoing legal precedent and the following reasons.

1. <u>Independent claim 30 and its dependent claims</u>

The combination of Xu and Paranthaman fails to teach a conductive layer that remains after the formation of the nanostructures

Independent claim 30 recites "at least one nanorod affixed to the substrate via the conductive epitaxial buffer layer and substantially disposed within the cavity, wherein the conductive epitaxial buffer layer remains after formation of the at least one nanorod."

The Xu and Paranthaman references, taken alone or in hypothetical combination, fail to teach or suggest the foregoing claim features. In particular, neither Xu nor Paranthaman teach employing a structure even remotely similar to the conductive buffer layer that remains after formation of the nanorods. Even assuming the metal catalyst film 87 of FIG. 5D or the metal catalyst film 108 of FIG. 6D of Xu as being equivalent to the conductive epitaxial buffer layer of the present claim, Appellants respectfully submit that the metal catalyst film is meant to dissolve into the gate metal during the heating in the process of formation of the nanorods. For example, a passage cited at col. 16, lines 5-10 discloses dissolving of the metal catalyst film during the formation of the nanorods. The cited passage reads:

> [H]eating in an atmosphere containing a carbon source to grow carbon emitters 78 on the exposed substrate inside of the gate openings. During heating, the metal catalyst on top of the gate metal dissolves into the gate metal and does not readily catalyze the formation of carbon fibers on the gate metal.

Therefore, the catalyst film will not remain when the nanorods are formed. Whereas, in the present claim, as illustrated in FIGS. 2D, 4D and 4E and as indicated in the description of a passage cited at paragraph 44, lines 3-9 of the present application, the present claim recites a conductive epitaxial buffer layer that remains after the formation of the nanorods to provided several advantageous features. The cited passage reads:

> The buffer layer 211 acts as a diffusion barrier and inhibits the formation of unwanted structures, such as silicides, due to interaction between the reactants and the substrate 110. The buffer layer 211 could include, for example, germanium carbide or silicon carbide applied in an epitaxial process, or a polycrystalline diffusion barrier such as W or Ti-W. In some cases the buffer layer 211 should be suitable to support epitaxial growth of the nanostructure materials of interest.

As mentioned in the cited passages, the conductive epitaxial buffer layer or the buffer layer facilitates growth of the nanostructures. Therefore, the present claim recites that the conductive epitaxial buffer layer remains after the nanostructures are formed.

Xu teaches away from having a conductive epitaxial buffer layer that remains until the formation of the nanostructures. Therefore, Xu teaches away from a combination with Paranthaman to employ a conductive epitaxial buffer layer that remains after the formation of the nanostructures. Accordingly, even if the field emission device of Xu was hypothetically formed by using the epitaxial buffer layers of Paranthaman, the device will not employ a conductive epitaxial buffer layer that remains after the formation of the nanostructures. For this reason, the Xu and Paranthaman references, taken alone or in hypothetical combination, cannot support a *prima facie* case of obviousness of independent claim 30 and its dependent claims.

In view of the foregoing discussion, the Appellants respectfully stress that the Xu and Paranthaman references, taken alone or in hypothetical combination, cannot support a *prima facie* case of obviousness of independent claim 30 and its dependent claims.

2. Independent claim 38 and its dependent claims

Cited references, taken alone or in hypothetical combination, fail to teach or suggest a conductive epitaxial buffer layer that remain after the formation of the nanostructures

Independent claim 38 recites "a plurality of elongated carburized metal nanostructures extending from the epitaxial conductive buffer layer, wherein the conductive epitaxial buffer layer remains after formation of the plurality of elongated carburized metal nanostructures, wherein the plurality of elongated carburized metal nanostructure comprises catalyst particles disposed between the epitaxial conductive buffer layer and the plurality of elongated carburized metal nanostructures at least prior

to growth of the plurality of elongated carburized metal nanostructures". As discussed above with reference to independent claim 30, the Xu reference teaches away from using a conductive buffer layer that remains after the formation of the nanostructures.

Additionally, Xu fails to teach or even suggest employing catalyst particles that are disposed between the conductive epitaxial buffer layer and the nanostructures. As illustrated in embodiments of FIGS. 2B and 2C and as described in paragraph 44, lines 1-3 of the present application, the catalyst particles are deposited on the conductive epitaxial buffer layer, and subsequently, the nanostructures are grown from the conductive epitaxial buffer layer, thereby resulting in the catalyst particles being present between the conductive epitaxial buffer layer and the nanostructures prior to the growth of the nanostructures. The cited passage reads:

> An electrically conductive buffer layer 211, as shown in FIGS. 2A-2D, may be applied to the substrate 110 prior to the step of applying a plurality of spatially-separated catalyst particles 112 to the substrate 110.

For at least these reasons, the Appellants respectfully stress that the Xu and Paranthaman references, taken alone or in hypothetical combination, cannot support a *prima facie* case of obviousness of independent claim 38 and its dependent claims.

3. Independent claim 44 and its dependent claims

Cited references, taken alone or in hypothetical combination, fail to teach or suggest a "conductive platform" such that the conductive platform is independent from catalyst particles as recited by independent claim 44.

Claim 44 recites "a conductive platform, having a top surface, disposed on the top side of the substrate within the cavity, wherein the conductive platform is independent from catalyst particles configured to grow the at least one nanorod."

Appellants respectfully submit that the Examiner is mistaken in considering the catalyst metal film of Xu equivalent to the conductive platform of the present claims. Although Appellants do not intend or suggest that the specification should be read into the claims, the Appellants reiterate that the specification is "the primary basis for construing the claims." *See Phillips v. AWH Corp.*, No. 03-1269, -1286, at 13-16 (Fed. Cir. July 12, 2005) (*en banc*). One should rely *heavily* on the written description for guidance as to the meaning of the claims. *See id.* As disclosed in the present application, the conductive platform facilitates the growth of the nanorods. *See* Application, paragraph 47, lines 1-3. The cited passage reads:

> In another embodiment, a conductive platform 420, as shown in FIG. 4, may be disposed on the substrate 310 within a cavity formed in the dielectric layer 314.

Appellants respectfully submit that Xu does not teach or suggest any structure analogous to the conductive platform as recited in claim 44. In other words, Xu fails to teach or suggest any structure which is employed to raise the level of nanorods close to the gate opening. The metal catalyst film is used as a catalyst to enhance the growth of the nanostructures. For example, a passage at col. 12, lines 27-33 of Xu recites:

> The use of a metal catalyst film is a preferred approach. The patterns are easy to form, uniform, and accurate with high reproducibility when a metal film is used. After a catalyst pattern is defined on a substrate surface, the patterned electron emitters are fabricated by further heating the substrate in an atmosphere containing a carbon source.

Therefore, if at all, the metal catalyst film of Xu may be hypothetically similar to the catalyst particles 404 in the foregoing passage, but the metal catalyst film of Xu cannot be equated with the conductive platform recited in the present claim.

In view of these passages, the Appellants further note that the present application discloses and claim 44 recites that the "catalyst particles are <u>disposed within a channel</u>" in the conductive platform to facilitate the growth of the nanostructures. For example, a passage in paragraph 47, lines 3-5, of the present application discloses:

> At least one channel 402 is formed in the conductive platform 420 and a catalyst particle 404 is placed within the channel 402. Nanorods 418 are then grown so as to extend from the top surface of the conductive platform 420.

Xu fails to disclose a conductive platform, and therefore fails to disclose the conductive platform that has catalyst particles disposed within a channel of the conductive platform.

The secondary references do not obviate the deficiencies of Xu. Hence, the hypothetical combination of Xu with Paranthaman fails to disclose a "conductive platform," as recited by independent claim 44. For at least these reasons, among others, the Appellants respectfully stress that the Xu and Paranthaman references, taken alone or in hypothetical combination, cannot support a *prima facie* case of obviousness of independent claim 44 and its dependent claims.

I. **Ground of Rejection Number 9:**

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claim 32 as being unpatentable over Xu in view of Paranthaman, and further in view of Kane. Claim 32 is dependent on independent claim 30. The Appellants stress that the Examiner's rejection is flawed in view of the deficiencies discussed in detail above. The additional reference does not obviate the deficiencies of Xu and Paranthaman.

J. **Ground of Rejection Number 10:**

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claim 33 as being unpatentable over Xu in view of Paranthaman, and further in view of Hunt. Claim 33 is dependent on independent claim 30. The Appellants stress that the Examiner's rejection is flawed in view of the deficiencies discussed in detail above. The additional reference does not obviate the deficiencies of Xu and Paranthaman.

K. **Ground of Rejection Number 11:**

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claim 34 as being unpatentable over Xu in view of Paranthaman, and further in view of Jin and Takai. Claim 34 is dependent on independent claim 30. The Appellants stress that the Examiner's rejection is flawed in view of the deficiencies discussed in detail above. The additional references do not obviate the deficiencies of Xu and Paranthaman.

L. **Ground of Rejection Number 12:**

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claims 37 and 52 as being unpatentable over Xu in view of Paranthaman, and further in view of Rowell. Claim 37 is dependent on independent claim 30. Claim 52 is dependent on independent claim 44. The Appellants stress that the Examiner's rejection is flawed in view of the deficiencies discussed in detail above. The additional reference does not obviate the deficiencies of Xu and Paranthaman.

M. **Ground of Rejection Number 13:**

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claim 41 as being unpatentable over Xu in view of Paranthaman, and further in view of Laude. Claim 41 is dependent on independent claim 38. The Appellants stress that the Examiner's rejection is flawed in view of the deficiencies discussed in detail above. The additional reference does not obviate the deficiencies of Xu and Paranthaman.

N. **Ground of Rejection Number 14:**

Appellants respectfully urge the Board to review and reverse the Examiner's rejection of claims 54-55 as being unpatentable over Xu in view of Narayan. The Appellants note that this rejection is redundant in view of the seventh rejection

summarized above. Therefore, the rejection is flawed for the same reasons as discussed in detail above.

Conclusion

Appellants respectfully submit that all pending claims are in condition for allowance. However, if the Examiner or Board wishes to resolve any other issues by way of a telephone conference, the Examiner or Board is kindly invited to contact the undersigned attorney at the telephone number indicated below.

Respectfully submitted,

Date: February 18, 2008

/Tait R. Swanson/
Tait R. Swanson
Reg. No. 48,226
FLETCHER YODER
P.O. Box 692289
Houston, TX 77269-2289
(281) 970-4545

8. APPENDIX OF CLAIMS ON APPEAL

30. A field emission device, comprising

a substrate having a top side and an opposite bottom side;

a conductive epitaxial buffer layer affixed to the top side of the substrate;

a dielectric layer disposed on the top side;

a conductive layer disposed on top of the dielectric layer opposite the substrate, the conductive layer and the dielectric layer defining a cavity extending downwardly to the substrate; and

at least one nanorod affixed to the substrate via the conductive epitaxial buffer layer and substantially disposed within the cavity, wherein the conductive epitaxial buffer layer remains after formation of the at least one nanorod.

32. The field emission device of Claim 30, employed in an imaging system.

33. The field emission device of Claim 30, employed in a lighting system.

34. The field emission device of Claim 30, wherein the nanorod is an X-nanorod, wherein X comprises a carbide, an oxide, a nitride, an oxynitride, an oxycarbide or a silicide, or combinations thereof.

35. The field emission device of Claim 30, wherein the substrate comprises an inorganic monocrystalline substance.

36. The field emission device of Claim 35, wherein the inorganic monocrystalline substance comprises silicon, an aluminum oxide, and silicon carbide, and combinations thereof.

37. The field emission device of Claim 30, wherein the dielectric layer comprises silicon dioxide, silicon nitride, silicon oxynitride, and aluminum oxide, and combinations thereof.

38. A nanostructure, comprising:

an inorganic substrate having a top side and a bottom side;

an epitaxial conductive buffer layer disposed adjacent to the top side; and

a plurality of elongated carburized metal nanostructures extending from the epitaxial conductive buffer layer,

wherein the epitaxial conductive buffer layer remains after formation of the plurality of elongated carburized metal nanostructures, and

wherein the plurality of elongated carburized metal nanostructures comprises catalyst particles disposed between the epitaxial conductive buffer layer and the plurality of elongated carburized metal nanostructures at least prior to growth of the plurality of elongated carburized metal nanostructures.

39. The nanostructure of Claim 38, wherein the inorganic substrate comprises a crystalline substance made of silicon, aluminum oxide, and silicon carbide, or combinations thereof.

40. The nanostructure of Claim 38, wherein the plurality of elongated carburized metal nanostructures comprises at least one nanorod.

41. The nanostructure of Claim 38, wherein the plurality of elongated carburized metal nanostructures comprises at least one nanoribbon.

42. The nanostructure of Claim 38, wherein the plurality of elongated carburized metal nanostructures each has a smaller dimension of less than 800 nm.

43. The nanostructure of Claim 38, wherein the carburized metal is carburized from an oxide of a metal comprising molybdenum, niobium, hafnium, silicon, tungsten, titanium, or zirconium, or combinations thereof.

44. A field emission device, comprising

a substrate having a top side and an opposite bottom side;

a dielectric layer disposed on the top side;

a conductive layer disposed on top of the dielectric layer opposite the substrate, the conductive layer and the dielectric layer defining a cavity extending downwardly to the substrate;

a conductive platform, having a top surface, disposed on the top side of the substrate within the cavity, wherein the conductive platform is independent from catalyst particles configured to grow the at least one nanorod, and the catalyst particles are disposed in a channel; and

at least one nanorod affixed to the top surface of the conductive platform and substantially disposed within the cavity.

45. The field emission device of Claim 44, wherein the conductive platform comprises a conic-shaped member having a relatively large bottom surface opposite the top surface, the bottom surface affixed to the substrate.

46. The field emission device of Claim 44, wherein the conductive platform comprises silicon, molybdenum, platinum, palladium, tantalum, or niobium, or combinations thereof.

47. The field emission device of Claim 44, wherein the nanorod is a carbide nanorod.

48. The field emission device of Claim 44, wherein the substrate comprises an inorganic monocrystalline substance.

49. The field emission device of Claim 48, wherein the inorganic monocrystalline substance comprises silicon, aluminum oxide and silicon carbide, or combinations thereof.

50. The field emission device of Claim 44, wherein the substrate comprises a polycrystalline material.

51. The field emission device of Claim 44, wherein the substrate comprises amorphous glass.

52. The field emission device of Claim 44, wherein the dielectric layer comprises silicon dioxide.

54. A field emission device, comprising

a substrate having a top side and an opposite bottom side;

a polycrystalline conductive diffusion barrier affixed to the top side of the substrate;

a dielectric layer disposed on the top side;

a conductive layer disposed on top of the dielectric layer opposite the substrate, the conductive layer and the dielectric layer defining a cavity extending downwardly to the substrate; and

at least one nanorod affixed to the substrate via the polycrystalline conductive diffusion barrier and substantially disposed within the cavity, wherein the at least one nanorod extends from a top surface of the polycrystalline conductive diffusion barrier.

55. A nanostructure, comprising:

an inorganic substrate having a top side and a bottom side;

a polycrystalline conductive diffusion barrier disposed adjacent to the top side; and

a plurality of elongated carburized metal nanostructures extending from the polycrystalline conductive diffusion barrier, wherein the polycrystalline conductive diffusion barrier is configured to inhibit formation of unwanted structures due to interaction between the inorganic substrate and reactants.

56. The field emission device of Claim 30, wherein the conductive epitaxial buffer layer is a diffusion barrier.

57. The field emission device of Claim 30, wherein the conductive epitaxial buffer layer is configured to inhibit formation of unwanted structures due to interaction between the substrate and reactants.

58. The field emission device of Claim 30, wherein the conductive epitaxial buffer layer is independent from catalyst particles configured to grow the at least one nanorod.

59. The field emission device of Claim 30, comprising catalyst particles disposed between the conductive epitaxial buffer layer and the at least one nanorod at least prior to growth of the at least one nanorod.

60. The field emission device of Claim 30, wherein the at least one nanorod extends from a top surface of the conductive epitaxial buffer layer.

61. The nanostructure of Claim 38, wherein the epitaxial conductive buffer layer is a diffusion barrier.

62. The nanostructure of Claim 38, wherein the epitaxial conductive buffer layer is configured to inhibit formation of unwanted structures due to interaction between the inorganic substrate and reactants.

63. The nanostructure of Claim 38, wherein the epitaxial conductive buffer layer is independent from catalyst particles configured to grow the plurality of elongated carburized metal nanostructures.

64. The nanostructure of Claim 38, wherein the plurality of elongated carburized metal nanostructures extends directly from a top surface of the epitaxial conductive buffer layer.

65. The field emission device of Claim 44, wherein the conductive platform supports the at least one nanorod in a raised position relative to the substrate.

66. The field emission device of Claim 44, wherein the conductive platform extends substantially around the at least one nanorod above the topside of the substrate after formation of the at least one nanorod.

67. The field emission device of Claim 44, wherein the conductive platform remains after formation of the at least one nanorod.

68. The field emission device of Claim 44, comprising catalyst particles disposed between the conductive platform and the at least one nanorod at least prior to growth of the at least one nanorod.

69. The field emission device of claim 54, wherein the polycrystalline conductive diffusion barrier remains after formation of the at least one nanorod.

70. The field emission device of claim 54, comprising catalyst particles disposed between the polycrystalline conductive diffusion barrier and the at least one nanorod at least prior to growth of the at least one nanorod.

71. The nanostructure of claim 55, wherein the polycrystalline conductive diffusion barrier remains after formation of the at least one nanorod.

72. The nanostructure of claim 55, wherein the plurality of elongated carburized metal nanostructures extends from a top surface of the polycrystalline conductive diffusion barrier.

9. **EVIDENCE APPENDIX**

None.

10. **RELATED PROCEEDINGS APPENDIX**

None.